



# What Does Industry Want from VV&A *Training*?

*A preliminary VV&A use case for aerospace*

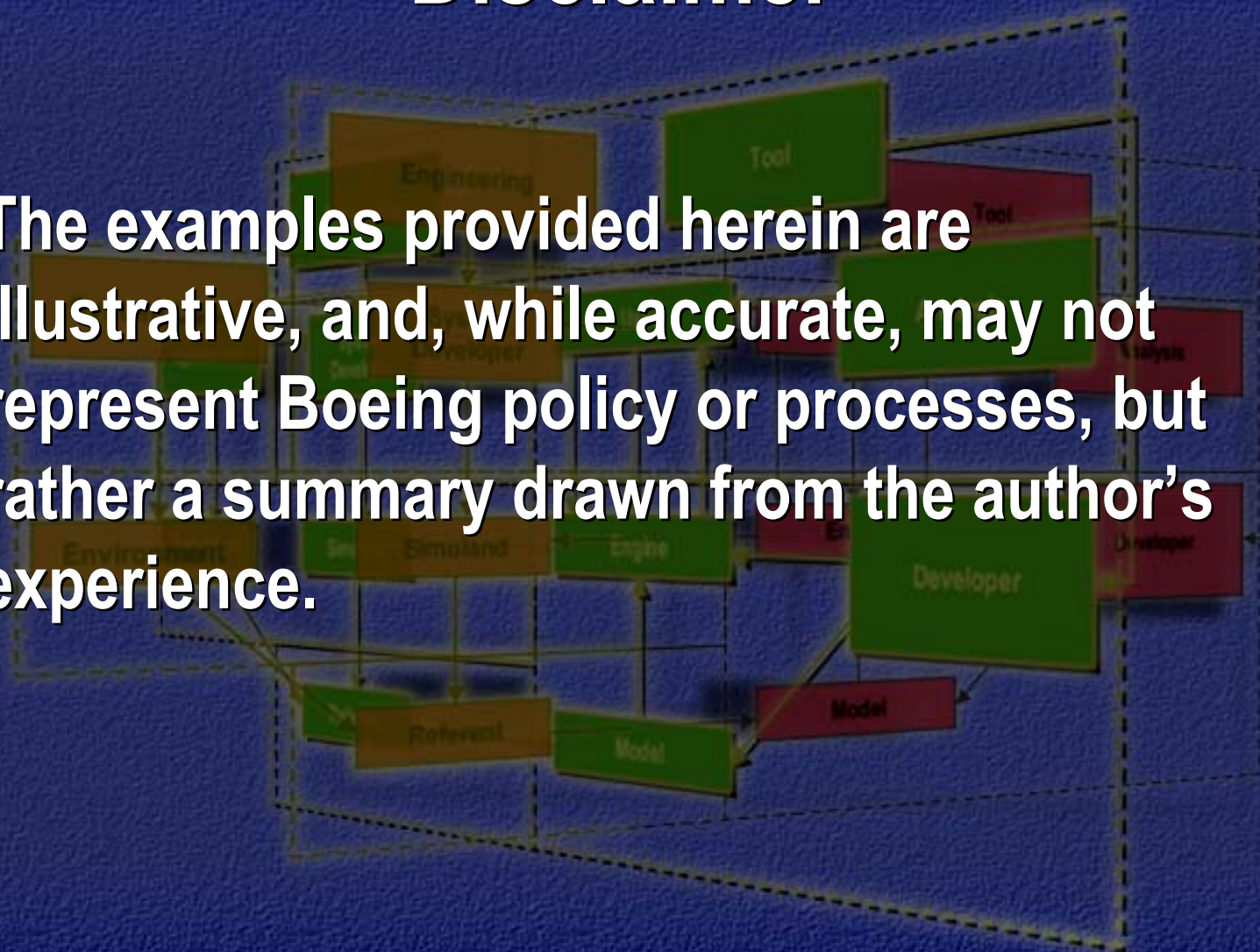
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# Disclaimer

The examples provided herein are illustrative, and, while accurate, may not represent Boeing policy or processes, but rather a summary drawn from the author's experience.





# A note on VV&A training

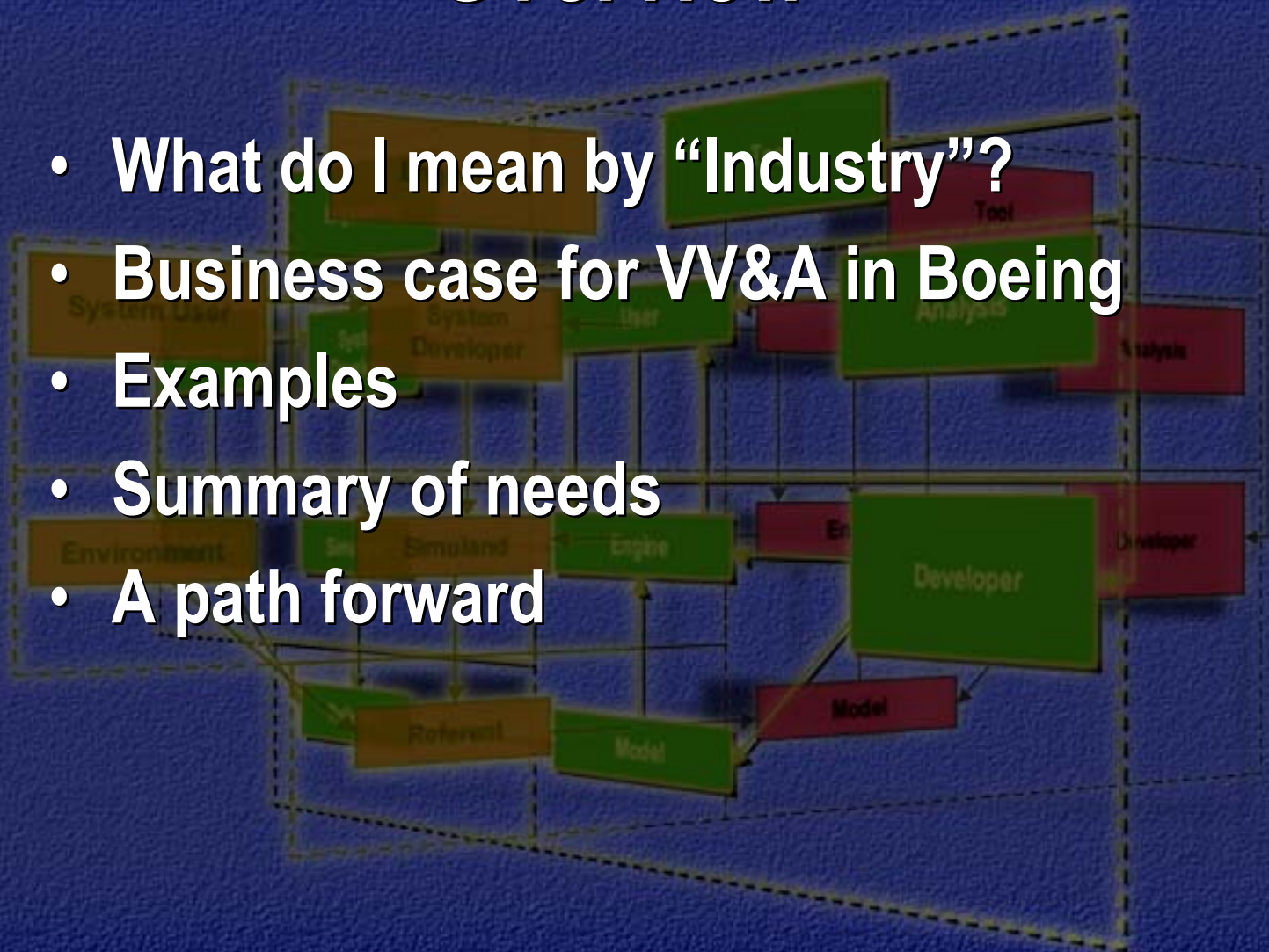
VV&A is an integral part of M&S development, and is described by engineering processes. Engineers are trained in those processes prior to executing them, as required by the CMM.

*This presentation describes the context, purpose, and objectives of that training.*



# Overview

- What do I mean by “Industry”?
- Business case for VV&A in Boeing
- Examples
- Summary of needs
- A path forward





# M&S Marketplace

	M&S Funding (External)	Operational Systems	Composed Simulations	M&S Technology	M&S Needs	M&S Standards	M&S Trained, Qualified People	Reusable M&S Components	Simulation Integration Tools	Model Development Tools	Engineering Tools	Domain Knowledge	M&S Infrastructure
Industry													
Government													
Academia													
Professional Societies													

**The market place is made up of producers, consumers, and commodities.**



# Industry Marketplace Detail

## Commodities

### Producers/Consumers

	M&S Funding (External)	Operational Systems	Composed Simulations	M&S Technology	M&S Needs	M&S Standards	M&S Trained, Qualified People	Reusable M&S Components	Simulation Integration Tools	Model Development Tools	Engineering Tools	Domain Knowledge	M&S Infrastructure
Major System Providers (primes)	B	O	B	B	B	B	B	B	B	B	B	B	B
M&S Tool Providers	I			I	I	O*	I		O	O	I		
M&S Service Providers	I		O	O	I	O*	B	O	B	O	I	I	B
Engineering Tool Providers	I				I	O*	I			O	O		
Infrastructure Providers	I				I	O*	I						O

**Legend:** I = Input, O = Output, B = Both, \* = Defacto Standard



# Government Marketplace Detail

	M&S Funding (External)	Operational Systems	Composed Simulations	M&S Technology	M&S Needs	M&S Standards	M&S Trained, Qualified People	Reusable M&S Components	Simulation Integration Tools	Model Development Tools	Engineering Tools	Domain Knowledge	M&S Infrastructure
System Acquisition Agencies	O	I	B	I	B	O	I	O	I	I		B	I
Technology Agencies	B		B	B	B	O	I	B	I	I			I
Policy Agencies			I		O		I					O	I
Analytic Agencies			B	I	B	B	I	I	I	I		B	I
Training Agencies	O		I	I	O	O	I	B	I	I		I	I
Test Agencies		B	B	I	B	O	I	B	I	I		I	I

**Legend:** I = Input, O = Output, B = Both



# Academic Marketplace Detail

	M&S Funding (External)	Operational Systems	Composed Simulations	M&S Technology	M&S Needs	M&S Standards	M&S Trained, Qualified People	Reusable M&S Components	Simulation Integration Tools	Model Development Tools	Engineering Tools	Domain Knowledge	M&S Infrastructure
M&S Educators			O	I	B	I	B	I	I	I	I	O	I
Engineering Educators			O	I	B	I	B	I	I	I	I	O	I
M&S Researchers	I		B	B	B		B	B	B	B	B		I
Other Researchers	I		B	B	B		B	B	B	B	B	B	I

**Legend:** I = Input, O = Output, B = Both



# Professional Societies Marketplace Detail

	M&S Funding (External)	Operational Systems	Composed Simulations	M&S Technology	M&S Needs	M&S Standards	M&S Trained, Qualified People	Reusable M&S Components	Simulation Integration Tools	Model Development Tools	Engineering Tools	Domain Knowledge	M&S Infrastructure
Information Exchange				B	B	I	B						
Standards Development				I	I	O	I						

**Legend:** I = Input, O = Output, B = Both



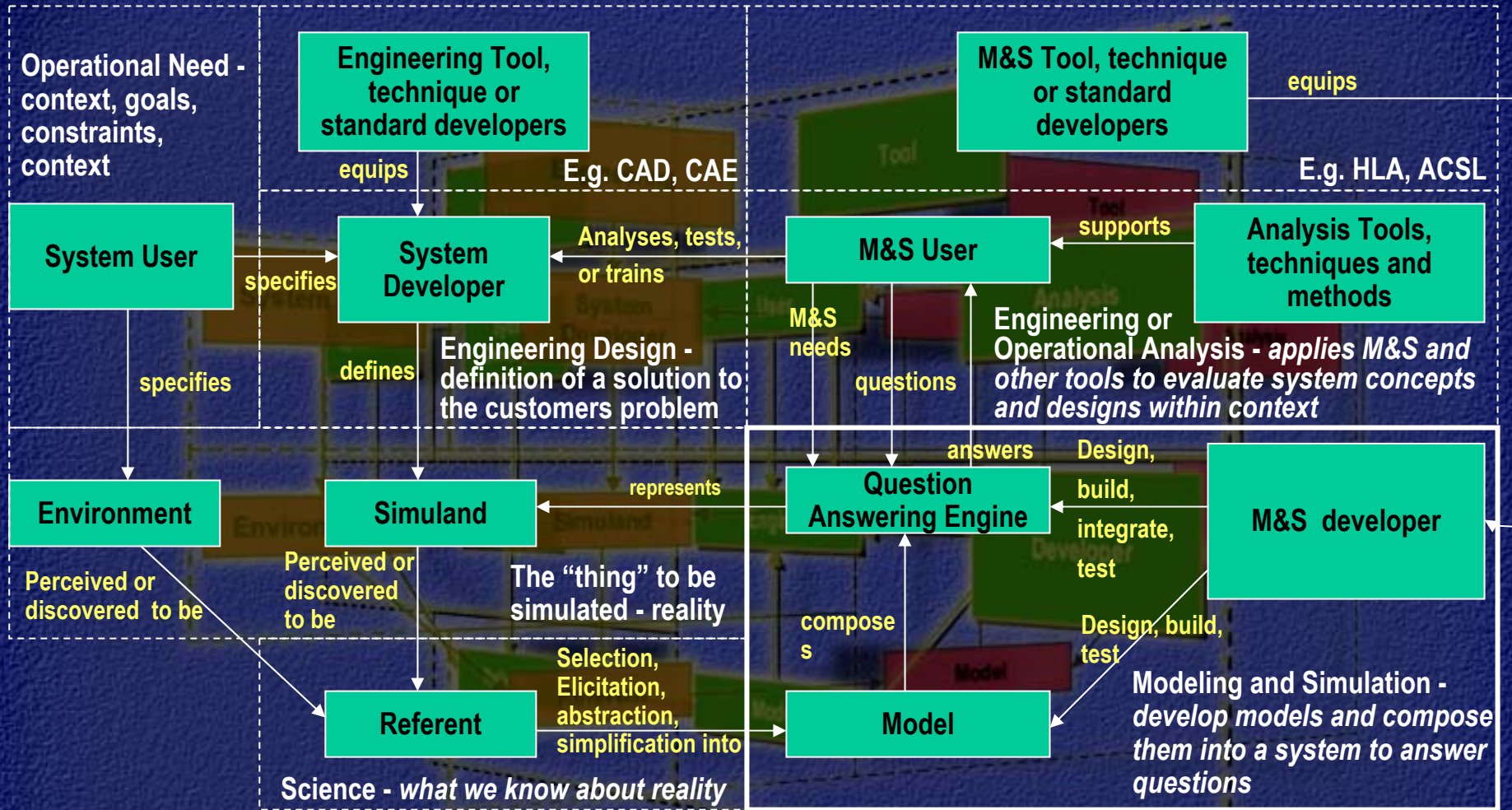
# M&S VV&A Business Case

- M&S is an integral part of Engineering & Manufacturing Process
- M&S is a competitive discriminator and core competency
- Focused effort to make it broad based, standardized, efficient, cost effective, and *credible*

*We need to know how much confidence to place in the answers we get from simulations, and understand how to apply them.*



# M&S in product development use case

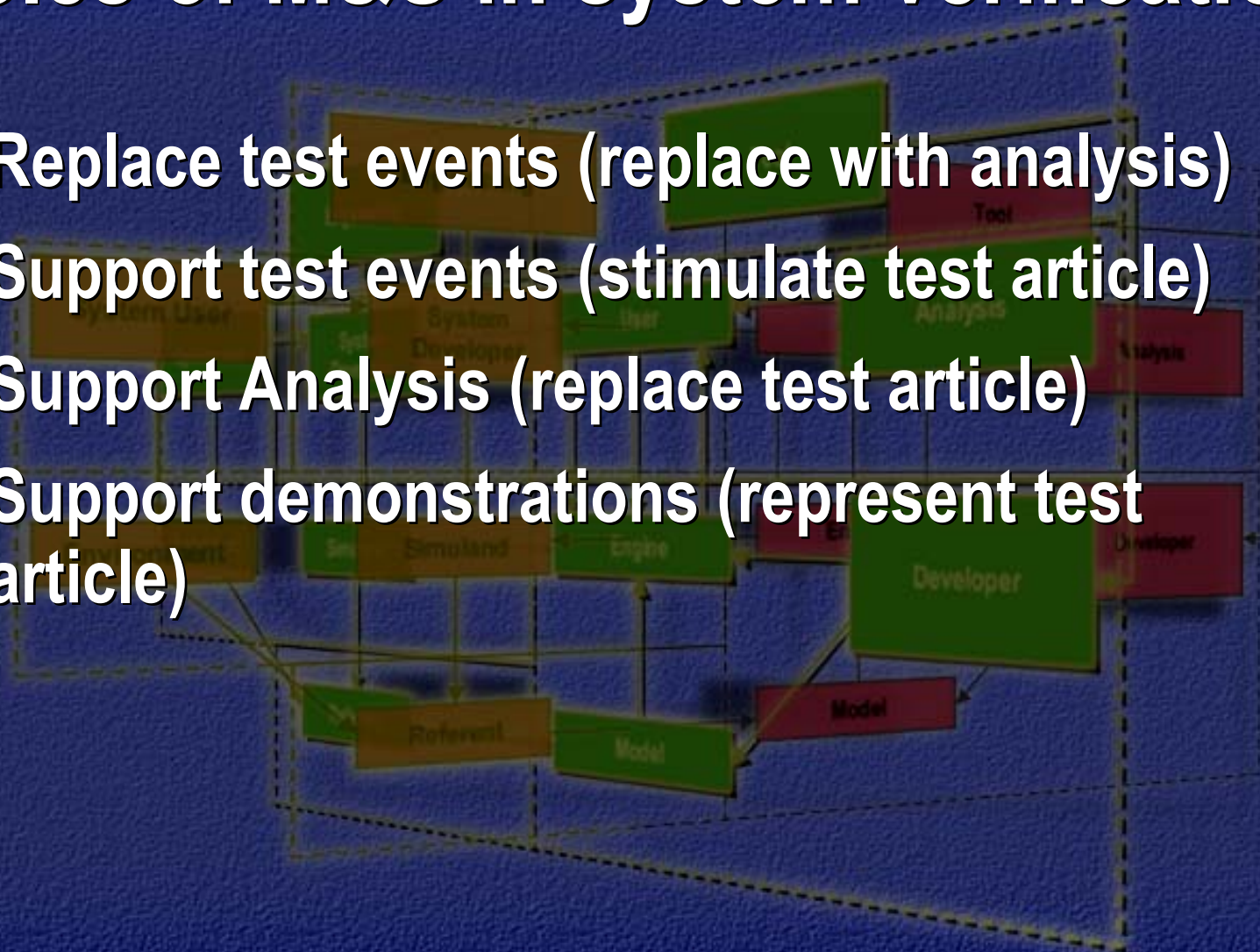


**Key:** Each box contains a class of person, or thing. Each arrow is a named relationship with the direction as shown.



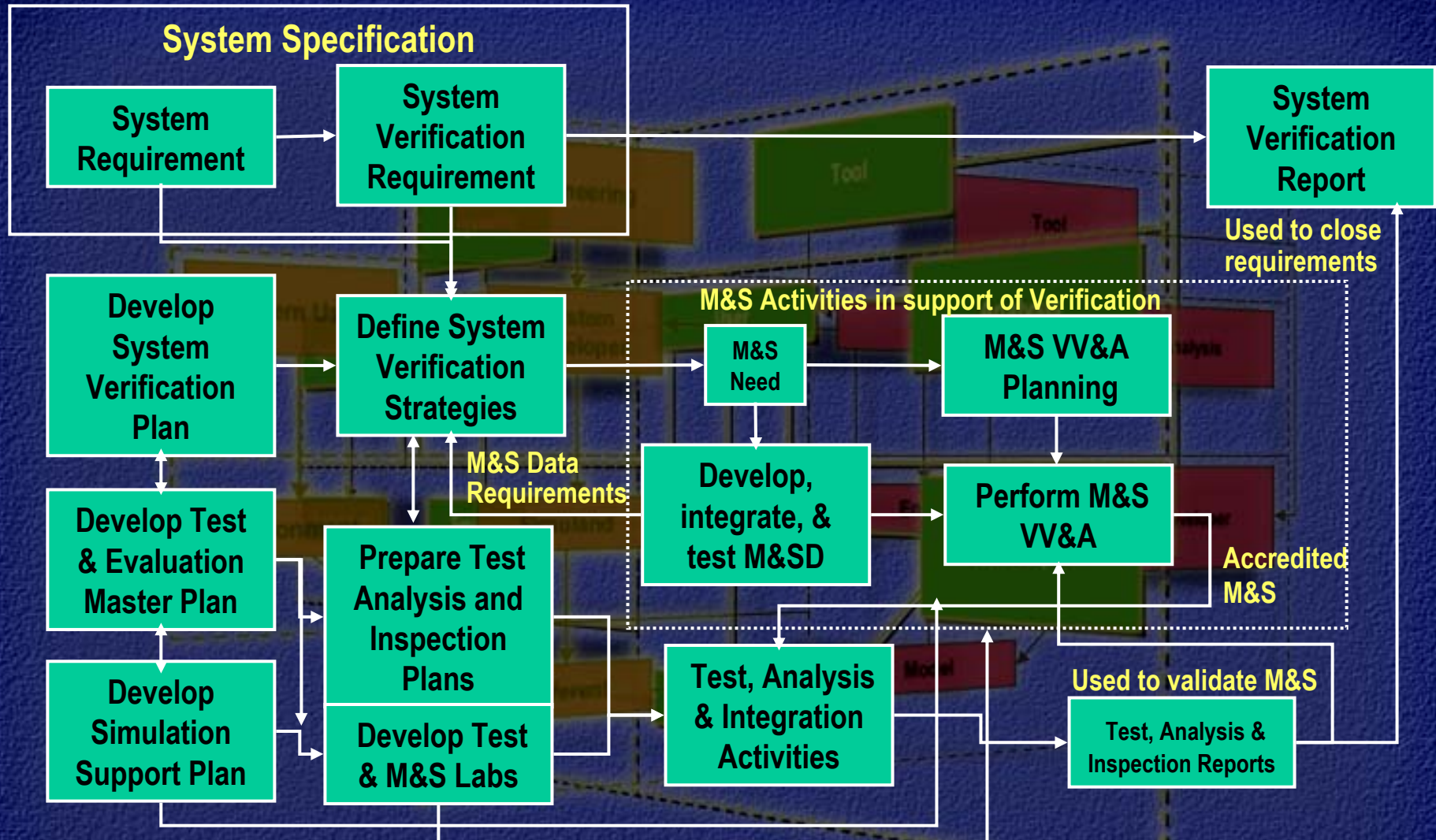
# Roles of M&S in system verification

- Replace test events (replace with analysis)
- Support test events (stimulate test article)
- Support Analysis (replace test article)
- Support demonstrations (represent test article)



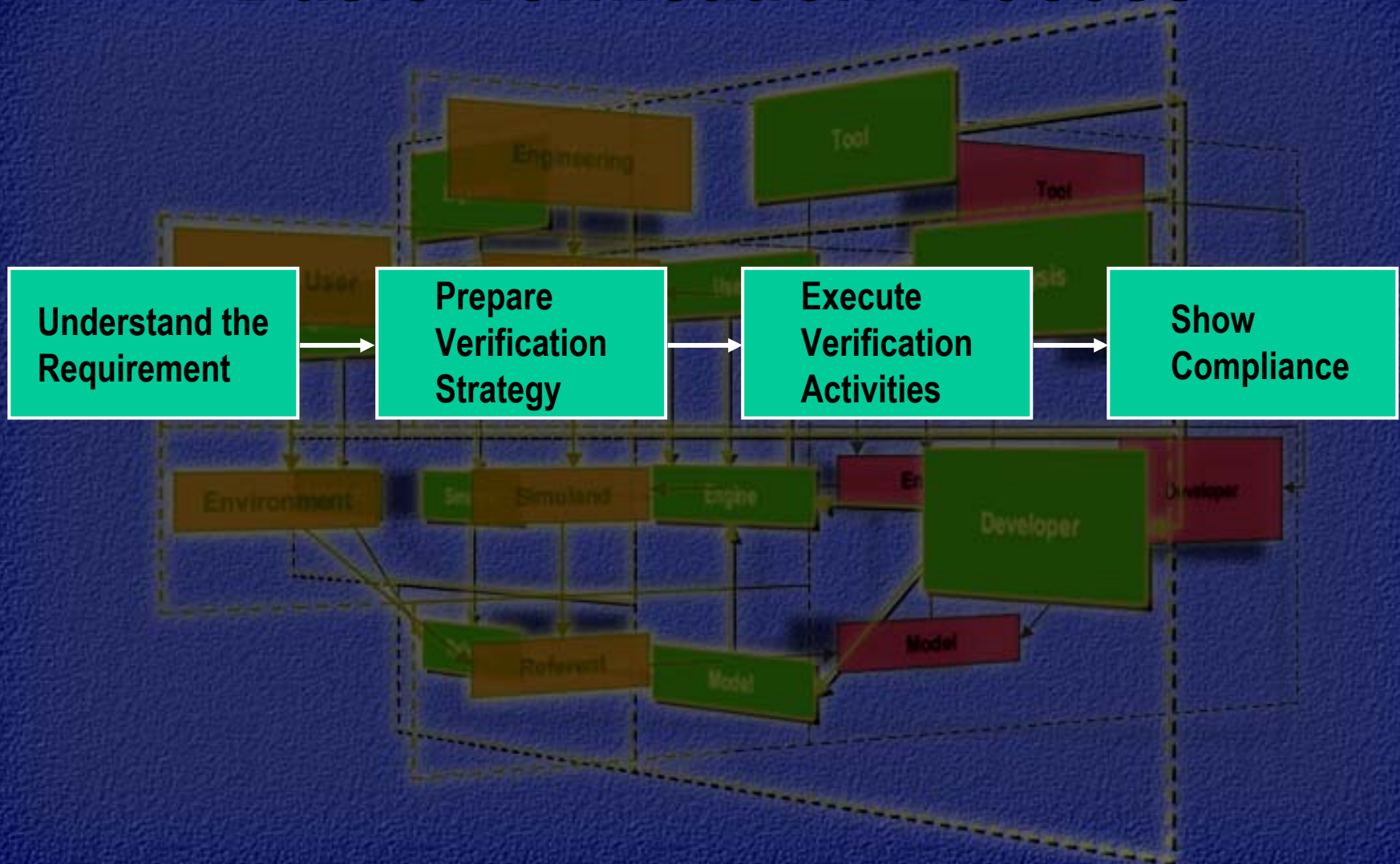


# System Verification using M&S



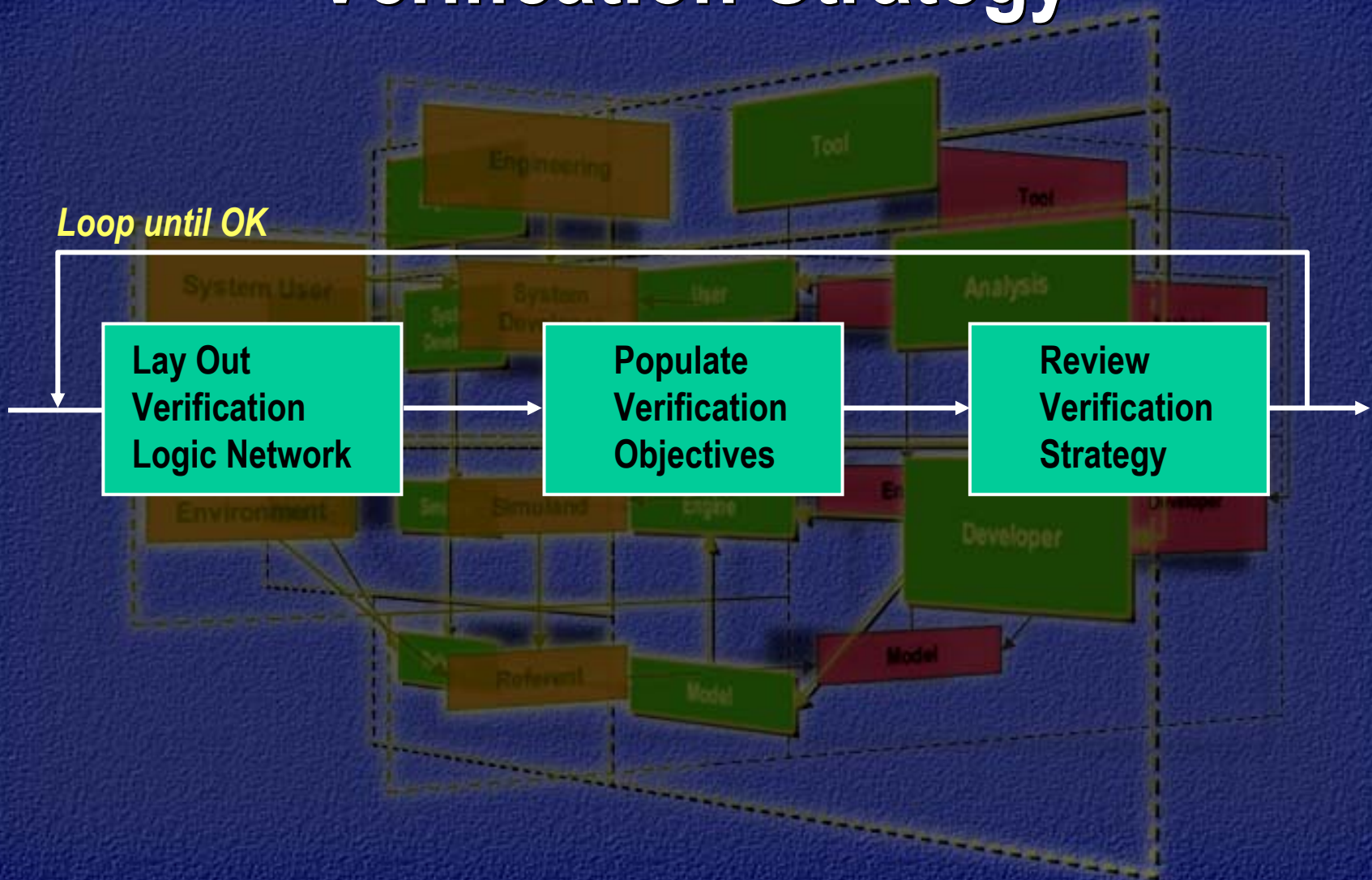


# Basic Verification Process



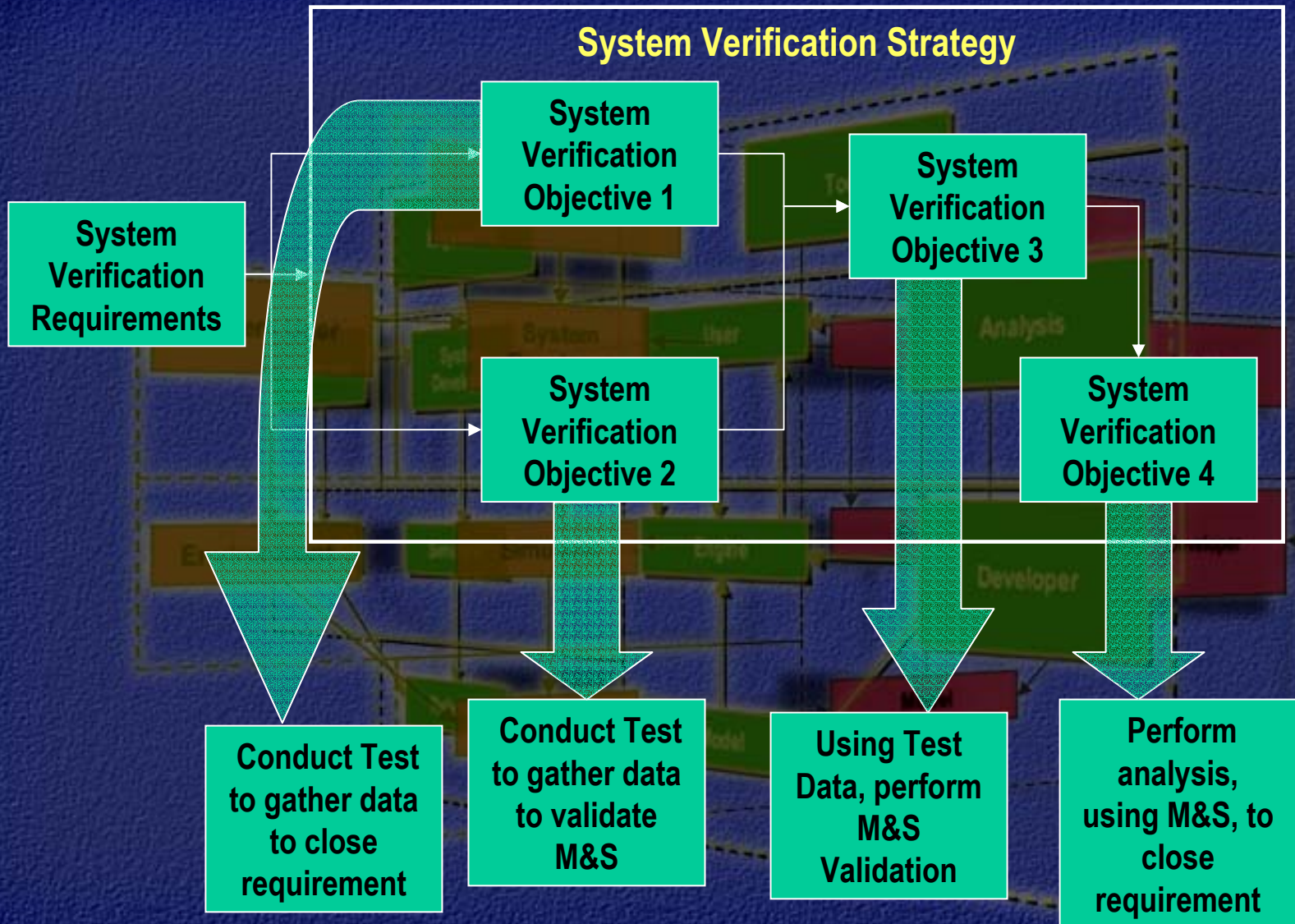


# Verification Strategy





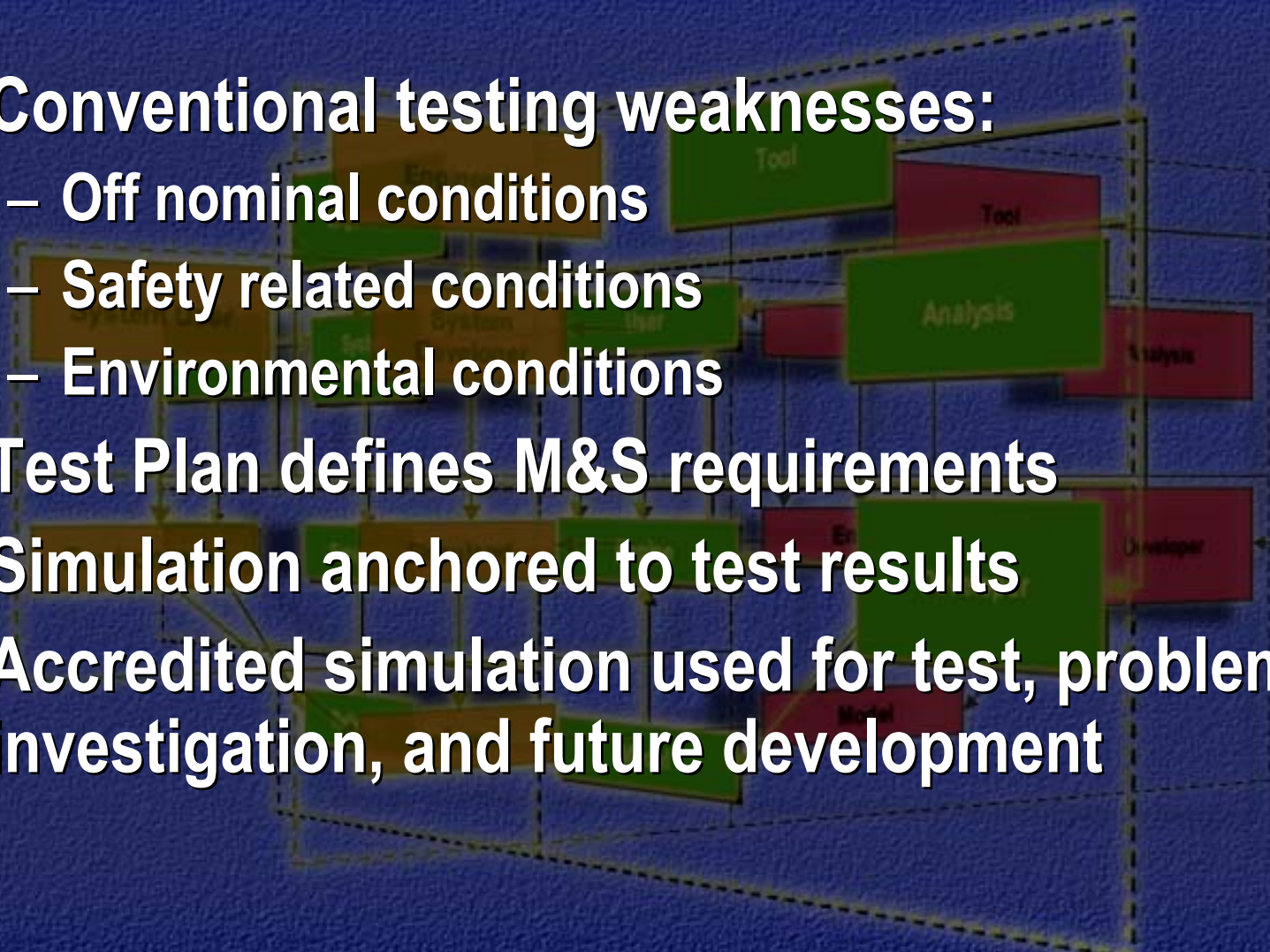
# Typical System Verification Interface to M&S





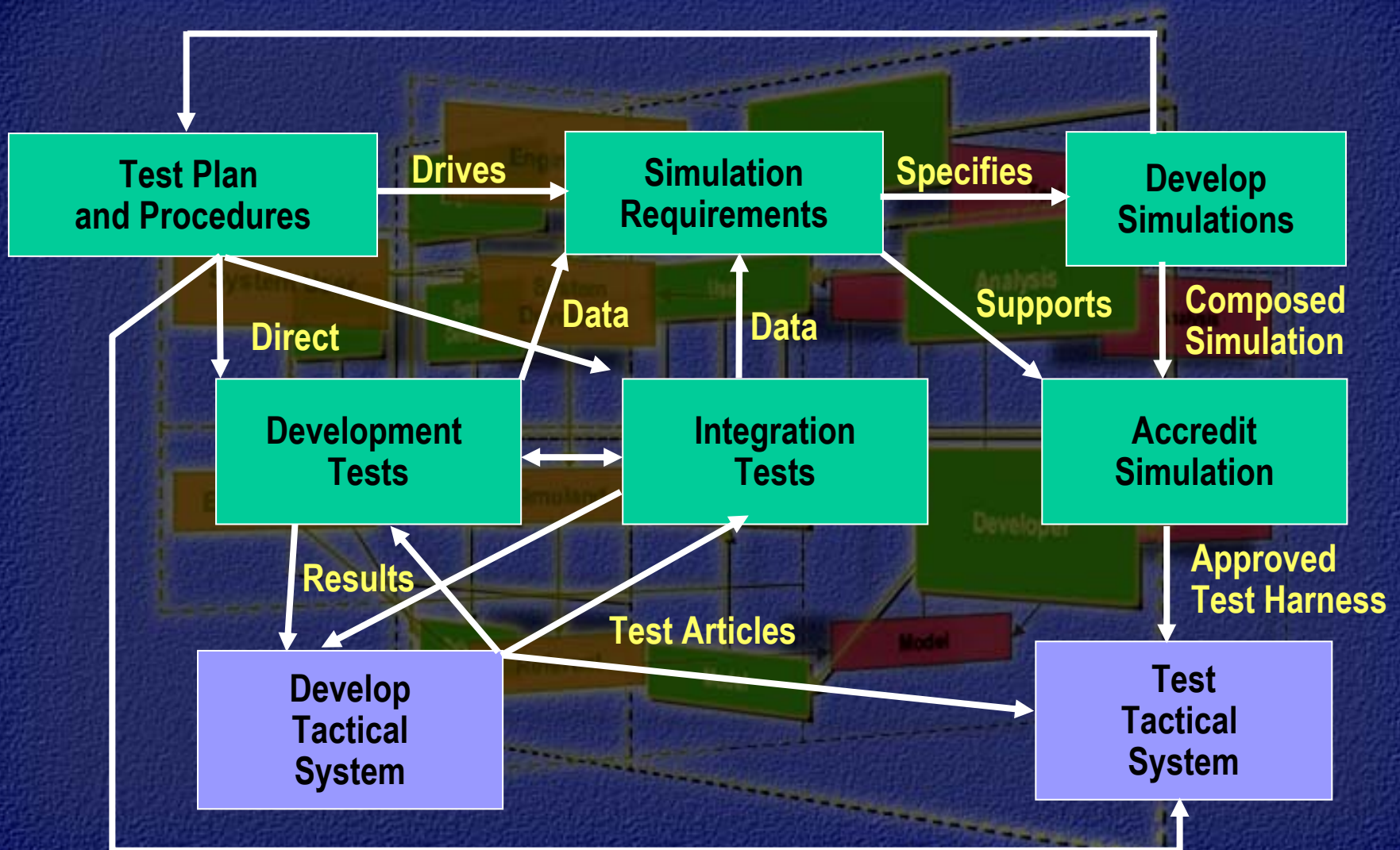
# The Role of M&S in Test and Evaluation

- Conventional testing weaknesses:
  - Off nominal conditions
  - Safety related conditions
  - Environmental conditions
- Test Plan defines M&S requirements
- Simulation anchored to test results
- Accredited simulation used for test, problem investigation, and future development





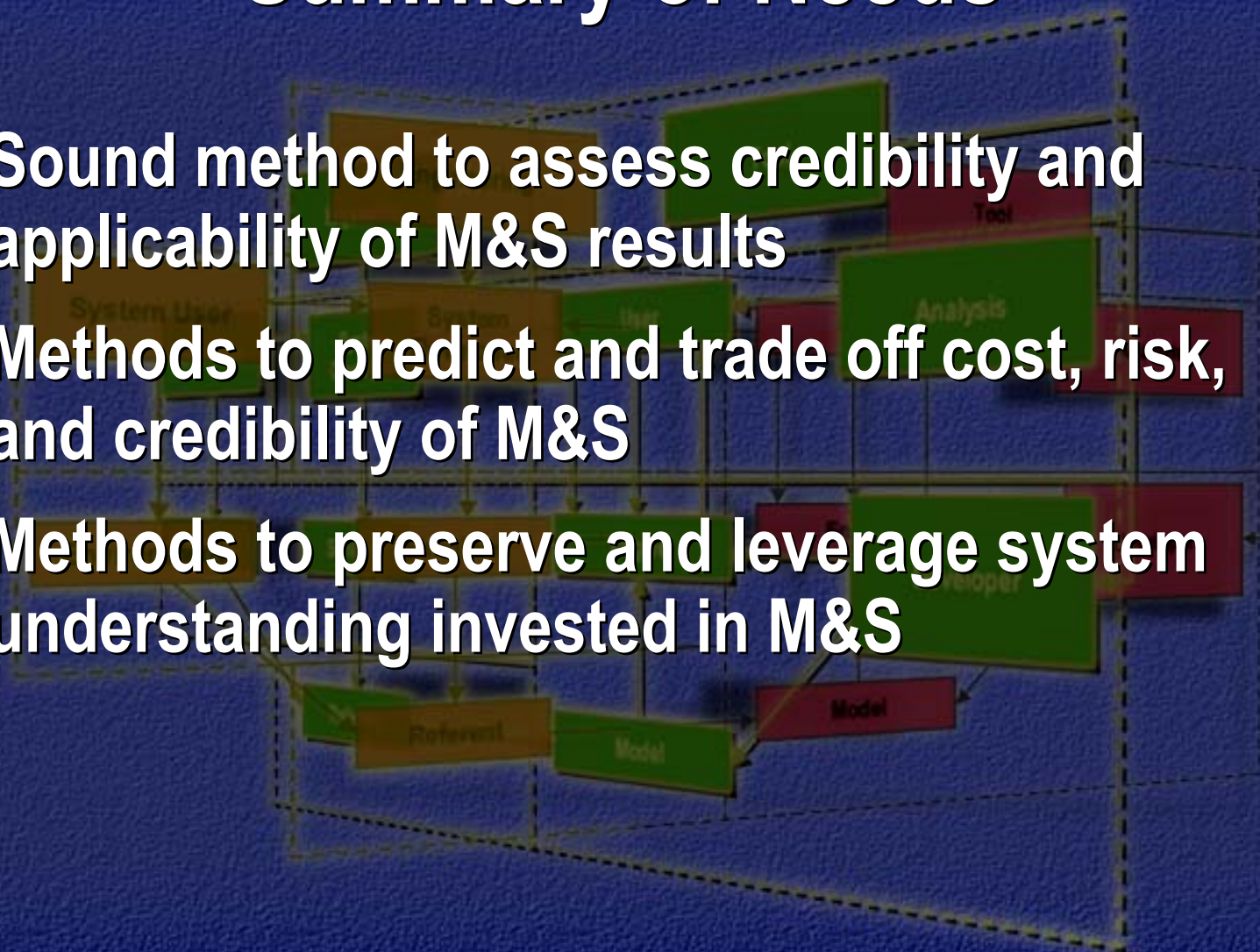
# M&S in Test





# Summary of Needs

- Sound method to assess credibility and applicability of M&S results
- Methods to predict and trade off cost, risk, and credibility of M&S
- Methods to preserve and leverage system understanding invested in M&S





# The Path Forward

- Emphasize cost benefit of VV&A in marketplace
- Insure techniques and tools correspond to needs
- Make sure we assess the value of the M&S against the need – *more accuracy/resolution/precision is not better if makes the answer too late, or too expensive!*